Preliminary Model of Time as Relational Sheen in a 4D Filamentary Spacetime

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Abstract

We present a tentative model wherein the phenomenon of time arises not as a fundamental dimension, but as an emergent feature — a relational *sheen* — resulting from local drift in the configuration of filamentary structures in a four-dimensional spacetime manifold. Filaments, representing particle worldlines, generate a dynamic relational geometry whose local stress and strain patterns propagate without the need for material flow, creating an apparent passage of time.

1 Introduction

We consider a four-dimensional differentiable manifold M, initially without an imposed metric structure. The manifold is populated by a dense ensemble of filaments, each defined as a smooth embedding:

$$\gamma : \mathbb{R} \to M, \quad \lambda \mapsto \gamma^\mu(\lambda), \tag{1}$$

where λ is an affine parameter along the filament.

The tangent vector to each filament is given by:

$$v^\mu(\lambda) = \frac{\mathrm{d}\gamma^\mu}{\mathrm{d}\lambda}. \tag{2}$$

2 Filament Congruence and Emergent Time

Define the local filament current:

$$J^\mu(x) = \sum_\gamma \int d\lambda \, v^\mu(\lambda) \delta^{(4)}(x - \gamma(\lambda)), \tag{3}$$

which encodes the local density and orientation of worldlines.

We propose that a local *time direction* arises dynamically as:

$$\tau_\mu(x) \propto J_\mu(x), \tag{4}$$

leading to a local scalar foliation field:

$$d\varphi(x) = \tau_\mu(x) \, dx^\mu. \tag{5}$$

3 Relational Drift and the Sheen Scalar

Consider two neighboring filaments with separation vector:

$$\delta x^\mu(\lambda) = \gamma_2^\mu(\lambda) - \gamma_1^\mu(\lambda). \tag{6}$$

Define the *relational strain tensor*:

$$S_{\mu\nu}(\lambda) = \delta x^\alpha(\lambda) \nabla_\alpha v_{(\mu} v_{\nu)}, \tag{7}$$

capturing the local misalignment and strain in the bundle of worldlines.

Introduce the scalar *sheen field*:

$$\mathcal{S}(x) = \sqrt{S_{\mu\nu}(x) S^{\mu\nu}(x)}, \tag{8}$$

which quantifies the magnitude of relational drift at each spacetime point.

4 Local Activation Rate and Time Flow

Define the local *sheen activation rate*:

$$\omega(x) = \frac{\mathrm{d}\mathcal{S}(x)}{\mathrm{d}\varphi}, \tag{9}$$

interpreted as the local rate of relational shift relative to the emergent foliation.

We tentatively propose that the *proper time increment* is given by:

$$d\tau \propto \omega(x)\, d\varphi. \tag{10}$$

Thus, the passage of time is associated with the evolving relational structure among worldlines.

5 Sheen Field Dynamics

As an initial hypothesis, we suggest that the sheen field satisfies a diffusion-like or wave-like equation:

$$\Box \mathcal{S}(x) - V'(\mathcal{S}(x)) = 0, \tag{11}$$

where $\Box$ is the d'Alembertian operator with respect to the emergent metric, and $V(\mathcal{S})$ is a potential governing the elasticity or resistance of relational drift.

6 Entropy and Time's Arrow

Finally, we propose that the local entropy density $s(x)$ is proportional to the relational strain:

$$s(x) \propto \mathcal{S}(x), \tag{12}$$

implying that entropy production is inherently tied to the growth of the relational sheen:

$$\frac{\mathrm{d}s}{\mathrm{d}\tau} \propto \omega(x). \tag{13}$$

7 Conclusion

In this tentative framework, time is not a fundamental backdrop but an emergent, relational phenomenon — a dynamic sheen arising from the slow migration of filamentary alignments in four-dimensional spacetime. This model opens avenues for further mathematical development, possible observational signatures, and connections to thermodynamic and quantum structures.

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